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Standard Design Certification with Prototype Testing

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INTRODUCTION

Standard design certification has been used over the past 20 years to develop NRC approval of Advanced Light Water Reactor (ALWR) designs. The standard design approval approach is intended to remove much of the uncertainty in the regulatory schedule prior to commitment of major funds to construction. The value of the approach has not been tested in the US but it has supported construction of ABWRs in Japan and Taiwan. Application of the approach to other types of advanced reactors may be possible but is not clear how this might be accomplished in the case of reactors with little or no operating experience. This paper discusses an approach that was proposed by General Electric over 15 years ago and its possible application to GEN-IV reactors.

PRISM PROGRAM

The concept of standard design certification with a prototype test was first considered early in the development of the Power Reactor Inherent Safe Module (PRISM)[1]. The concept was also considered for application to the Modular High Temperature Gas Reactor (MHTGR) being developed at that time by General Atomics [2]. The concept has been commonly referred to as licensing by test and continues to be of interest to both small liquid metal cooled reactors (LMRs) and small modular gas cooled reactors. Application of the concept to small light water cooled reactors and other types of reactors has not received as much attention, but it might also be applied to small advanced reactors of all types. This paper is based on recent reconsideration of application to small LMRs [3]. Either lead alloy or sodium cooled.

REGULATORY CONSIDERATIONS

The motivation for the GE proposed revision to 10CFR50 was the recognized cost and schedule savings that could be realized from a certified standard design. It was also believed that this was an especially appropriate approach to licensing a design that was, to a large extent, to be factory manufactured and assembled, and incorporated passive safety features not available in LWRs at that time. However, it was also recognized that the experience with design certification regulations was limited to LWRs. And the LWRs requesting design certification were based on extensive design, manufacturing, construction and operating experience. Applying the design certification regulations to a first-of-a-kind design such as PRISM was without precedent Key elements included in the original GE proposal were the introduction of a prototype test and a document called the Certification Basis Agreement [2]. These additions to the design certification process provided a process for addressing issues associated with design certification of first-of-a-kind reactor. Many questions, including the site selection and licensing of the prototype test facility remain to be addressed.

COMPARISON TO COMMERCIAL AIRCRAFT CERTIFICATION

The concept of certification using a prototype test was developed with full consideration of the FAA procedure for certifying commercial aircraft. It appeared that the emphasis on safety of commercial aircraft was comparable to that applied to a nuclear reactor and the benefit of resolving all the safety and design issues prior to production was a common objective. In addition, in some aircraft cases the certification was accomplished without extensive experience on a specific new design. However, in addition to the standard production design documentation, safety analysis and component testing, there is a requirement for extensive testing of the first production or prototype machine over a wide range of operational and emergency conditions. The scope of the certification test program was established prior to conduct of the test and included testing beyond the range of normal operation and anticipated events.

IMPACTS ON NUCLEAR POWER SYSTEM DESIGN

The proposed approach for possible revision of the NRC regulations will impact how one designs an advanced reactor. The design should be one for which the need for a large number of units can be anticipated. There can be no design changes important to safety without a re-certification. These two requirements lend themselves to plants that incorporate many smaller modules rather than large monolithic plants. Advanced reactor plants with large nuclear units are unlikely to be built in sufficiently large numbers without design change, therefore the benefits of design certification are unlikely to be realized until several plants have been built.

ANTICIPATED BENEFITS

The PBMR experience indicates that although the 10CFR52 regulations do not exclude advanced reactor applications there are unresolved issues that will take time to resolve. There may be no procedure short of involving the Commissioners to reach resolution of some of these. Revising the regulations along the lines proposed by GE would reduce the schedule uncertainty by addressing many open issues that exist with the application of existing regulations.

CONCLUSIONS

Development of revised regulations for standard design certifications will be beneficial to selected advanced reactor concepts. Regulatory revisions based on the use of a prototype test appear to be most suitable for small reactor modules for which production of a large number of standard units is anticipated. In the case of large monolithic designs, it is not clear that the proposed approach will have the same value.

REFERENCES

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